Claims

1. A semi-convective forced air system for heating glass sheets during a heating cycle, comprising:

a heating chamber having a length and a width,

at least one heating element located within the heating chamber,

a conveyor having a length and a width, the conveyor extending lengthwise through the heating chamber,

a compressed air source,

a plurality of air manifolds positioned within the heating chamber and in fluid connection with the compressed air source, each of the air manifolds having a length, and each of the air manifolds being oriented parallel to the length of the conveyor, and

a plurality of nozzle means mounted on each air manifold and in fluid connection with the air manifold for mixing together and directing toward the conveyor a combination of compressed air and over air to convectively heat a sheet of glass on the conveyor, the plurality of nozzle means on each air manifold being spaced along the length of the air manifold.

2. The system of claim 1,

the air manifolds being arranged in at least one withwide-extending column.

3. The system of claim 1,

the air manifolds being arranged in a side-by-side fashion in a horizontal plane above the conveyor.

4. The system of claim 1,

each manifold being segmented into a plurality of segments, with

each segment being connected to the compressed air source, with each segment being oriented parallel to the length of the conveyor, and with each segment having at least one nozzle means mounted therein.

5. The system of claim 1,

said air manifolds being arranged in a first bank, and further including

at least one additional bank of air manifolds positioned within the heating chamber and in fluid connection with the compressed air source, each air manifold in the at least one additional bank of manifolds having a length and being oriented parallel to the length of the conveyor, and

a plurality of nozzle means mounted on and in fluid connection with each air manifold in the at least one additional bank of air manifolds for directing a combination of compressed air and oven air toward the conveyor to convectively heat a sheet of glass on the conveyor, the plurality of nozzle means on each air manifold in the at least one additional bank of air manifolds being spaced along the length of each air manifold in the at least one additional bank of air manifolds.

6. The system of claim 1,

the plurality of nozzle means on each air manifold being spaced in a series along the length of the air manifold with each adjacent nozzle means being mounted on opposite sides of the air manifold.

7. The system of claim 1,

a body having an upper end portion, a lower end portion, and an opening formed in the lower end portion,

a compressed air chamber formed in the body, the compressed air chamber having an outlet port,

compressed air inlet means formed in the body for introducing compressed air into the compressed air chamber, and

oven air conduit means extending through the body and the compressed air chamber for conveying oven air to a location immediately proximate to and downstream of the outlet port of the compressed air chamber, the oven air conduit means having an inlet end portion and an outlet end portion,

the outlet port of the compressed air chamber being formed by a gap between the outlet end portion of the oven air conduit means and an insert piece mounted in the opening formed in the lower end portion of the body, the insert piece having a bore extending downwardly therethrough for receiving compressed air from the outlet port of the compressed air chamber and oven air from the oven air conduit means, the bore having a first end portion into which compressed air enters from the compressed air chamber through the outlet port of the compressed air chamber and oven air enters from the oven conduit means through the outlet end of the oven air conduit means, and the bore having a second end portion from which the compressed air and the oven air that enters the bore exits the nozzle,

wherein oven air is drawn into and through the oven air conduit means and into the bore in the insert piece in response to compressed air moving through the gap formed between the outlet end portion of the oven air conduit means and the insert piece mounted in the opening formed in the lower end portion of the body, is mixed with the compressed air in the bore, and is expelled from the nozzle from the second end portion of the bore.

8. The system of claim 7,

the oven air conduit means having an outer surface,

the outer surface of the oven air conduit means at the outlet end portion of the oven air conduit means being angled inwardly to form an inwardly angled outer surface portion,

the first end portion of the bore flaring outwardly, and

the inwardly angled outer surface portion of the oven air conduit means being aligned next to the first end portion of the bore to define the gap.

9. The system of claim 7,

the oven air conduit means comprising an upwardly extending hollow tube,

the tube have a length sufficiently long to enable oven air located adjacent to a heating element in the oven to be drawn into the tube when the nozzle is in use in an oven.

10. The system of claim 1,

each nozzle means having an upper end portion for drawing in oven air located adjacent to the heating element into the nozzle.

11. The system of claim 1,

each nozzle means being positioned in the oven such that oven air located adjacent to the heating element is drawn into the nozzle.

12. The system of claim 1, further including

a distribution manifold in fluid connection with compressed air source and each air manifold.

13. The system of claim 12, further including

a valve in fluid connection with the distribution manifold, and

a controller connected to the valve for controlling how much compressed air is supplied to selected manifolds at predetermined times

during a heating cycle.

14. The system of claim 4, further including

a distribution manifold in fluid connection with the compressed air source and each manifold segment,

a valve and a flow meter in fluid connection with the distribution manifold, and

a controller connected to the compressed air source for controlling how much compressed air is supplied to selected manifold segments at predetermined times during a heating cycle.

15. The system of claim 1, further including

an air regulator, a filter/dryer, and a valve positioned in fluid connection between the compressed air source and the distribution manifold.

16. The system of claim 13,

the controller being a computer programmable to open and close the valve at predetermined times during a heating cycle.

17. The system of claim 14,

the controller being a computer programmable to open and close the valve at predetermined times during a heating cycle.

18. The system of claim 1,

the air manifolds being positioned in the heating chamber above the conveyor.

19. A semi-convective oven nozzle for mixing and directing downwardly a combination of compressed air and oven air to convectively heat a sheet of glass on the conveyor, comprising

a body having an upper end portion, a lower end portion, and an

opening formed in the lower end portion,

a compressed air chamber formed in the body, the compressed air chamber having an outlet port,

compressed air inlet means formed in the body for introducing compressed air into the compressed air chamber, and

oven air conduit means extending through the body and the compressed air chamber for conveying oven air to a location immediately proximate to and downstream of the outlet port of the compressed air chamber, the oven air conduit means having an inlet end portion and an outlet end portion,

the outlet port of the compressed air chamber being formed by a gap between the outlet end portion of the oven air conduit means and an insert piece mounted in the opening formed in the lower end portion of the body, the insert piece having a bore extending downwardly therethrough for receiving compressed air from the outlet port of the compressed air chamber and oven air from the oven air conduit means, the bore having a first end portion into which compressed air enters from the compressed air chamber through the outlet port of the compressed air chamber and oven air enters from the oven conduit means through the outlet end of the oven air conduit means, and the bore having a second end portion from which the compressed air and the oven air that enters the bore exits the nozzle,

wherein oven air is drawn into and through the oven air conduit means and into the bore in the insert piece in response to compressed air moving through the gap formed between the outlet end portion of the oven air conduit means and the insert piece mounted in the opening formed in the lower end portion of the body, is mixed with the compressed air in the bore,

and is expelled from the nozzle from the second end portion of the bore.

20. The nozzle of claim 19,

the oven air conduit means having an outer surface,

the outer surface of the oven air conduit means at the outlet end portion of the oven air conduit means being angled inwardly to form an inwardly angled outer surface portion,

the first end portion of the bore flaring outwardly, and

the inwardly angled outer surface portion of the oven air conduit means being aligned next to the first end portion of the bore to define the gap.

21. The nozzle of claim 19,

the oven air conduit means comprising an upwardly extending hollow tube,

the tube have a length sufficiently long to enable oven air located adjacent to a heating element in the oven to be drawn into the tube when the nozzle is in use in an oven.

22. A semi-convection oven air injector for mixing and injecting downwardly toward a conveyor in an oven an external source of compressed air and oven air to convectively heat a sheet of glass being conveyed through the oven on the conveyor comprising:

a body having a compressed air inlet port, an oven air inlet port, and a mixed air outlet port,

a first conduit having an inlet end and an outlet end, the first conduit extending from the compressed air inlet portion to the mixed air outlet port, and the first conduit having a constricted throat at an intermediate portion, and

a second conduit having an inlet end and an outlet end, the second conduit extending from the oven air inlet port to the constricted throat, and the second conduit outlet end being coaxial with and located immediately proximate to the constricted throat of the first conduit downstream of the constricted throat, the constricted throat forming a venturi which creates a high pressure region in the first conduit upstream of the constricted throat and a low pressure region in the conduit downstream of the constricted throat,

wherein oven air is drawn into and through the second conduit into the low pressure region, and is mixed with the compressed air, and is expelled from the mixed air outlet port.

23. A semi-convective forced air system for heating glass sheets during a heating cycle, comprising:

a heating chamber having a length and a width,

at least one heating element located within the heating chamber,

a conveyor having a length and a width, the conveyor extending lengthwise through the heating chamber,

a compressed air source,

an air manifold positioned within the heating chamber and in fluid connection with the compressed air source, the air manifold having a length, and the air manifold being oriented parallel to the length of the conveyor, and

a plurality of nozzle means mounted on the air manifold and in fluid connection with the air manifold for directing a combination of compressed air and oven air toward the conveyor to convectively heat a sheet of glass on the conveyor, the plurality of nozzle means being spaced along the

length of the air manifold.

24. A method of heating a sheet of glass for subsequent processing, comprising the steps of:

loading a sheet of glass onto a conveyor having a length that extends through a heating chamber of an oven,

orienting the sheet of glass such that its lengthwise edge is parallel to length of the conveyor,

conveying the sheet into the heating chamber, and

convectively heating in a specified sequence the entire length of selected widthwise portions of the sheet of glass by creating a downward flow of heated air onto the selected widthwise portions of the sheet of glass using a plurality of nozzle means mounted in the heating chamber for mixing and directing onto the sheet of glass in a wide and uniform pattern a combination of compressed air and oven air.

25. The method of claim 24,

the oven air being drawn by the nozzle from a location close to a heating element in the heating chamber.